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THE PREVALENCE OF VISUAL DEFICIENCIES AMONG 1979 GENERAL AVIATI--ETC(U)
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16. Abstract

Analyses of the accident experience of pilots who were monocular, did not meet (even the liberal) vision standards, had color vision defects and no operational restrictions, or wore contact lenses, have shown higher-than-expected accident experience in previous studies. However, no causal role had been assigned by accident investigators and reexamination of the records failed to show any obvious pattern or relationship between the defects and the accidents. In the present study of 1979 accidents, the relatively small number of pilots with aphakia and artificial lens implants, as well as the total eye pathology population, had significantly higher accident rates, but the monocular pilots did not. Again, no causal role had been ascribed. Some associations are debatable, but there is no clear recurring problem.

There are still unresolved questions about the consistent operational performance of monocular pilots, those who are not fully corrected to 20/20 distant visual acuity bilaterally, airmen with near vision deficiencies only who are not required to wear corrective glasses, those without fusion, and several with appreciable pathology who have 20/20 corrected central visual acuity but about whom we know very little concerning their dynamic, peripheral, depth or accommodative function.

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THE PREVALENCE OF VISUAL DEFICIENCIES AMONG 1979 GENERAL AVIATION ACCIDENT AIRMEN

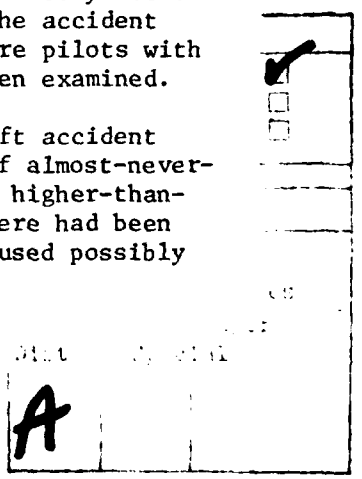
INTRODUCTION

The eyes are considered to be the most important sensory organs for aerospace flight. Some experts in aerospace medicine consider normal distant and near visual acuity, color vision, depth perception, field of vision, and accommodation necessary for safe flight. Yet, of 827,592 active civil airmen at the end of 1979, 350,701 (42%) required corrective lenses (20,058 of these were known to wear contact lenses), 15,127 had failed standard office tests of color vision, 5,156 were considered monocular, about 15,000 had other eye pathology, and none had been tested for depth perception or for accommodation.

Aircraft accident and student pilot performance records were used by Drs. Bauer and Cooper to check on the adequacy of civil aviation medical standards in 1929-31 (1,2). Vision standards received particular attention. We have previously examined and reported the accident experience of airmen with selected static physical defects for 1974, 1975, and 1976, using rate per 100,000 self-reported flying hours and observed to expected ratio methods (3,4,5). All physical conditions with significantly higher accident rates were vision categories. Pilots with blindness or absence of either eye had significantly higher accident observed to expected ratios all 3 years and higher rates per 100,000 hours in 1975 and 1976 (the only 2 years that rates were calculated); contact lens wearers had a higher observed to expected ratio 2 of 3 years tested and a higher rate the only year it was calculated; airmen with deficient distant vision had higher observed to expected ratios, significant at 0.01, all 3 years but a higher rate only 1 year, and then only when based on cumulative flight hours to date; and those with deficient color vision and no operational restriction had a significantly (at 0.001) higher observed to expected ratio all 3 years but no significant increase in rate either year when based on flight experience the past 6 months.

A vision defect was cited as an accident cause or factor in only 1 accident of 1,246 involving pilots with static physical defects studied in the 3 years. Review of all these accident reports failed to reveal any association between the vision defects and midair collisions, landing accidents, weather, darkness, or type of flying except for more agricultural accidents by monocular pilots than were expected 1 year. Still, further study seemed to be indicated considering the statistical significance of the accident experience for some of the categories. In addition, there were pilots with 16 other eye pathologies whose accident experience had not been examined.

We immediately began disseminating information to aircraft accident investigators about the existence and possible implications of almost-never-cited airman physical defects. We made plans to check on the higher-than-expected number of accident airmen (8 of 36 in 1976) where there had been errors in measuring and coding distant visual acuity which caused possibly



improper assignment to the monocular category and to determine the accident rates for those who were fully corrected (to 20/20) and those who were not fully corrected in the deficient distant vision category.

METHOD

Complete FAA accident records were available for 3,764 of the 4,051 general aviation aircraft accidents that occurred during 1979.

The frequencies of 19 eye pathologies and of medically assigned, vision-related operational restrictions in the 827,592 active airmen as of December 31, 1979, and in the pilots involved in the 3,764 aircraft accidents during 1979 were determined.

Rates per 1,000 airmen and per 1,000 accidents were calculated for the 19 conditions and for the restrictions. Significance was determined by using the critical ratio rate test and, because of the small numbers in some instances, by the Yates correction to the chi-square test.

All medical records for airmen with these eye pathologies who had accidents in 1979 were reviewed for accuracy and currency of assigned codes.

All the reports for accidents that these airmen had were reviewed for ascribed causal roles, details of the accidents, and likelihood of eye pathology being a factor.

Also, all reports of midair collisions in 1979 were reviewed and eye test results for all involved pilots were considered for any likely causal role.

RESULTS AND DISCUSSION

The 19 eye pathologies, their frequencies in the active airman population and in pilots who had accidents in 1979, rates per 1,000 for both frequencies, and significance of the accident experience by the critical ratio rate test and the corrected chi-square test are given in Table I. The eye pathology total, aphakia, and artificial lens implant groups had significantly higher accident than population representation by both tests, and airmen with a pathology code for abnormality of the pupil had a significantly higher rate only by the corrected chi-square test.

Multiple eye pathologies are fairly common. There were 173 individuals with 207 of these eye pathology diagnoses who had 174 accidents; 17 had two conditions, 5 had three, 1 had four, and 1 had five. Those with multiple diagnoses frequently wore contact lenses or had artificial lens implants to compensate for aphakia, in one or both eyes, resulting from cataract surgery. It should be noted that most corrective lens users are carried under a restriction code, not a pathology code, as are 6,431 with a color vision defect who carry a limitation, "not valid for night flight or by color signal control." Those who fail to meet vision standards and 8,696 with defective

TABLE 1. AIRMAN AND ACCIDENT FREQUENCIES FOR SELECTED EYE PATHOLOGY CATEGORIES

Eye Pathology	Frequency in Airman Population Dec. 1979	Rate per 1,000 Airmen	Frequency in 1979 Accidents	Rate per 1,000 Accidents	Rate Test	χ^2_c Test
Diplopia	167	0.2	0	0	-	-
Nystagmus	91	0.1	0	0	-	-
Tropia	1,235	1.5	5	1.3	0.34	0.002
Disease or defect of external eye	188	0.2	2	0.5	0.85	0.49
Disease of cornea	867	1.0	4	1.1	0.18	0.05
Disease of iris	291	0.4	3	0.8	0.86	1.05
Abnormality of pupil	621	0.8	7	1.9	1.53	4.81**
Aphakia	1,140	1.4	13	3.4	2.12**	10.38**
Cataract	1,459	1.8	11	2.9	1.26	2.26
Disease of optic nerve	106	0.1	0	0	-	-
Disease of retina	793	1.0	3	0.8	0.43	0.003
Glaucoma	1,067	1.3	3	0.8	1.08	0.38
Scotoma	163	0.2	2	0.5	0.85	0.78
Keratoconus	88	0.1	0	0	-	-
Artificial lens implant	173	0.2	4	1.1	1.64*	9.39**
Contact lens use	20,058	24.2	95	25.2	0.38	0.12
Blindness or absence of an eye	5,156	6.2	31	8.2	1.36	2.14
Amblyopia	1,419	1.7	4	1.1	1.09	0.60
Other eye disease	3,951	4.8	20	5.3	0.42	0.13
Totals	39,033	47.2	207	55.0	2.04**	4.98**

*Significant at 0.10. **Significant at 0.05.

color vision have a statement of demonstrated ability (waiver) and are coded accordingly.

None of the eye pathologies was ascribed a causal or contributory role in the FAA accident reports, nor was any association certain from our review.

In those accidents involving pilots with aphakia and contact lens use, one (with aphakia corrected to 20/20 distant vision left eye, 20/50 corrected to 20/20 distant vision right eye) hit snowdrifts on landing; one (20/15 distant vision right eye, aphakia corrected to 20/30 left eye) hit wires while spraying a field; one (bilateral aphakia corrected to 20/30 and 20/40) collapsed the nose gear on landing and the aircraft nosed over onto its back; and an 88-year-old pilot (bilateral aphakia corrected to 20/30) landed the aircraft more than 6,000 feet down the runway at a high rate of speed, and it bounced several times and went off the side of the runway as it approached the runway end, this after a 4-hour flight above 10,000 feet without oxygen.

The aphakia and artificial lens implant group accident causes included gusty wind on taxi, fuel starvation, and mechanical failure. An aerial applicator with bilateral lens implants had two accidents; one occurred when visibility reportedly went from 2 miles to 0-0 between takeoff and landing while flying around the airport traffic pattern, and the other when there was loss of directional control and the aircraft flipped over when he landed on a road to refuel during spraying operations. The pilot recommended "better directional control through proper visual reference in 3 dimension" in his accident report.

Monocular pilots did not have an increased accident rate this year for the first time in over 4 years of investigation. None was incorrectly coded by our staff, and only three intermittently qualified as monocular--one was variously reported as 20/100 and 20/200 best corrected vision in one eye, another was reported to have 20/100 distant vision acuity in one eye on one exam and "no useful vision" in the same eye on another occasion, and the third was reported as being "blind" and having 20/70 acuity in the same eye on separate physical examinations. There had been eight measurement and coding errors in 1976.

Monocular pilot accidents included loss of directional control on a touch-and-go landing, ground looped on landing, undershot the runway due to a downdraft, wind gust, left the runway on landing, hit a sand dune during a low pass over a beach, flared too high, lost control on landing roll, hit a cow on the runway (dark), hit water on a sod strip and veered into a ditch, hit a mailbox on takeoff from a road, missed the runway due to partial airport light failure, and hit short of the runway due to a sudden rain shower on final approach. A witness to the last accident said "he was just too low." While several of these are landing accidents, it should be pointed out that slightly over 40 percent of general aviation accidents occur during the landing phase of operation.

The possibility that excuses are given to cover poor techniques or vision has been raised before. The probability that we really know too

little about the actual visual requirements in aviation and very little about the dynamic visual capabilities of airmen with several eye pathologies is a more recent concern.

Two of the thirty-one monocular pilot accidents involved aerial application and both were mechanical problems.

We were disappointed to find that 19 of these 31 monocular pilots had normal or full field of vision recorded on their last physical examinations.

Of 46 pilots involved in 23 midair collisions, 1 had exotropia and 17 had corrective lenses restrictions.

The frequencies of six vision-related, medically assigned operational restrictions in the active civilian airman population and in pilots who had accidents during 1979, the rates of these restrictions per 1,000 airmen and per 1,000 accidents, and the significance of the accident experience by the critical ratio rate test and the corrected chi-square test are given in Table II. The airmen who needed near vision corrections but were not required

TABLE II. AIRMAN AND ACCIDENT FREQUENCIES FOR VARIOUS OPERATIONAL RESTRICTIONS

Restriction	Frequency in Airman Population Dec. 1979	Rate per 1,000 Airmen	Frequency in 1979 Accidents	Rate per 1,000 Accidents	Rate Test	χ_c^2 Test
Must have available glasses for near vision	72,121	87.2	369	98.0	2.11*	5.49*
Must wear corrective lenses	201,740	243.8	849	225.6	2.34**	6.70**
Must wear glasses for near and distant vision	70,388	85.1	322	85.5	0.08	0.01
Must wear corrective lenses for distant vision and possess glasses for near vision	190	0.3	0	0	-	-
Must wear prismatic correction	60	0.1	2	0.5	1.13	5.54*
Must wear corrective lenses; extra pair must be available	6,202	7.5	28	7.4	0.07	0.003

*Significant at 0.05. **Significant at 0.05 but accident group rate better than population rate.

to be wearing corrective spectacles had significantly (at 0.05) higher accident experience than population representation by both tests. While there are possible explanations for causal roles, we did not examine the accident reports for these nonpathology airmen in the course of this study. The only other group wherein statistical significance (at the 0.05 level) was observed was for the group required to wear prismatic correction. The number of observed accidents is, however, so small as to make these results questionable.

A comparison of the accident rates for pilots who exceed visual acuity standards but are fully corrected and those who are not fully corrected was not possible during this study.

SUMMARY

Because of the very large civilian airman population in the United States and the policy of the Federal Aviation Administration to set physical standards and medical certification policy as liberal as safety responsibilities will permit, large numbers of pilots with various visual defects are expected, as is their representation in the airman population who had accidents. Certification in doubtful cases follows review of the airman's medical records, an ophthalmological evaluation, possibly a practical flight test, and consideration by the Federal Air Surgeon with the assistance of consultants. Careful consideration is given before more liberal policies are established.

Analyses of the accident experience of pilots who were monocular, did not meet (even the liberal) vision standards, had color vision defects and no operational restrictions, or wore contact lenses have shown higher-than-expected accident experience in previous studies. However, no causal role had been assigned by accident investigators and reexamination of the records failed to show any obvious pattern or relationship between the defects and the accidents. In the present study of 1979 accidents, the relatively small number of pilots with aphakia and artificial lens implants, as well as the total eye pathology population, had significantly higher accident rates, but the monocular pilots did not. Again, no causal role had been ascribed. Some associations are debatable, but there is no clear recurring problem.

There are questions about the functional importance of 20/30 and 20/40 best corrected visual acuity in one case, an entry of "no fusion" in another, and the dynamic, peripheral, depth, and accommodative performance of several with appreciable pathology who have a corrected central acuity of 20/20.

Clearly, from responsibility and interest, this type of study needs to continue and findings should influence the design of research on contemporary problems in aviation medicine. Meanwhile, continuing emphasis must be placed on the accurate measurement of visual functions required for medical certification in communications with Federal Aviation Administration aviation medical examiners.

REFERENCES

1. Cooper, H. J. 1930. The relations between physical deficiencies and decreased performance. J. Aviat. Med. 1:4-26.

2. Cooper, H. J. 1931. Further studies on the effect of physical defect on flying ability. J. Aviat. Med. 2:162-171.

3. Dille, J. R., and C. F. Booze, Jr. 1976. Accident experience of civilian pilots with static physical defects. FAA Office of Aviation Medicine Report No. AM-76-7.

4. Dille, J. R., and C. F. Booze, Jr. 1977. The 1975 accident experience of civilian pilots with static physical defects. FAA Office of Aviation Medicine Report No. AM-77-20.

5. Dille, J. R., and C. F. Booze, Jr. 1979. The 1976 accident experience of civilian pilots with static physical defects. FAA Office of Aviation Medicine Report No. AM-79-19.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